

WHAT IS CLAIMED IS:

1        1.        A motor controller for simultaneously  
2        controlling operations of at least two system motors by  
3        pulse-width modulation, comprising:

4                a pair of switches for supplying driving power  
5        to a pair of system motors among said at least two system  
6        motors, respectively;

7                a pair of pulse signal generators for generating  
8        a pair of pulse signals respectively having predetermined  
9        duty ratios at predetermined cycles, and outputting said  
10       pulse signals to said pair of switches to turn on or off  
11       said pair of switches; and

12               inversion means for inverting, with respect to  
13       a phase of one of said two pulse signals that is generated  
14       and output by one of said two pulse signal generators,  
15       a phase of the other of said two pulse signals, which is  
16       generated and output by the other of said two pulse signal  
17       generators, by 180 degrees.

1       2.        The motor controller as set forth in claim 1,  
2       wherein said one pulse signal is caused to rise at a leading  
3       edge of said predetermined cycle, and by inverting the  
4       phase of said other pulse signal by 180 degrees by said  
5       inversion means, said other pulse signal is caused to fall  
6       at said leading edge.

1        3.            The motor controller as set forth in claim 1,  
2        further comprising:  
3                    a counter for counting a clock signal,  
4        outputting the count to said pair of pulse signal generators,  
5        and resetting said count at said predetermined cycles;  
6                    wherein said pair of pulse signal generators  
7        compare said count from said counter with duty set values  
8        that are set at said predetermined cycles to determine  
9        said predetermined duty ratios, and generate and output  
10       said two pulse signals according to the result of comparison,  
11       respectively;  
12                    and wherein said inversion means is constructed  
13       as a phase shifter that inverts a phase of said count that  
14       is output from said counter to said other pulse signal  
15       generator, with respect to a phase of said count that is  
16       output from said counter to said one pulse signal generator.

1       4.            The motor controller as set forth in claim 1,  
2       further comprising restriction means that, when there is  
3       overlap of said two pulse signals in which said pair of  
4       switches are simultaneously turned on by said one pulse  
5       signal and said other pulse signal that is inverted by  
6       said inversion means, selects one of said two pulse signals  
7       and adjusts a waveform of the selected pulse signal to  
8       restrict operation of the switch that is turned on by said  
9       selected pulse signal.

1       5.           The motor controller as set forth in claim 4,  
2       wherein said restriction means comprises:  
3               priority-order determination means for  
4       determining the priority order of said two system motors,  
5       based on the content of a predetermined operation request  
6       made on said two system motors and characteristics of a  
7       device to be driven by said two system motors;  
8               restriction-ratio setting means for setting,  
9       based on the content of said predetermined operation  
10      request and the characteristics of said device, a  
11      restriction ratio of said overlap so that operations of  
12      said two system motors, which are performed according to  
13      said predetermined operation request, end simultaneously;  
14      and  
15              adjustment means for selecting as said selected  
16      pulse signal a pulse signal that is output to the motor  
17      with lower priority determined by said priority-order  
18      determination means, and adjusting a waveform of said  
19      selected pulse signal according to said restriction ratio  
20      set by said restriction-ratio setting means.

1       6.           A conveyance robot for conveying a cartridge  
2       with a storage medium in a library apparatus that has a  
3       shelf for storing said cartridge and a deck for accessing  
4       said storage medium, comprising:  
5              a hand mechanism for inserting and removing said  
6       cartridge while grasping said cartridge;

7                   a moving mechanism, which includes two system  
8                   motors, for two-dimensionally moving said cartridge  
9                   grasped by said hand mechanism; and  
10                   a control unit for simultaneously controlling  
11                   operations of said two system motors by pulse-width  
12                   modulation;  
13                   wherein said control unit comprises:  
14                   a pair of switches for supplying driving power  
15                   to said two system motors, respectively,  
16                   a pair of pulse signal generators for generating  
17                   a pair of pulse signals respectively having predetermined  
18                   duty ratios at predetermined cycles, and outputting said  
19                   pulse signals to said pair of switches to turn on or off  
20                   said pair of switches, and  
21                   inversion means for inverting, with respect to  
22                   a phase of one of said two pulse signals that is generated  
23                   and output by one of said two pulse signal generators,  
24                   a phase of the other of said two pulse signals, which is  
25                   generated and output by the other of said two pulse signal  
26                   generators, by 180 degrees.

1       7.           The conveyance robot as set forth in claim 6,  
2                   wherein said control unit causes said one pulse signal  
3                   to rise at a leading edge of said predetermined cycle,  
4                   and by inverting the phase of said other pulse signal by  
5                   180 degrees by said inversion means of said control unit,  
6                   said other pulse signal is caused to fall at said leading

7 edge.

1 8. The conveyance robot as set forth in claim 6,  
2 wherein:

3 said control unit further comprises a counter  
4 for counting a clock signal, outputting the count to said  
5 pair of pulse signal generators, and resetting said count  
6 at said predetermined cycles;

7 said pair of pulse signal generators compare  
8 said count from said counter with duty set values that  
9 are set at said predetermined cycles to determine said  
10 predetermined duty ratios, and generate and output said  
11 two pulse signals according to the result of comparison,  
12 respectively; and

13 said inversion means is constructed as a phase  
14 shifter that inverts a phase of said count that is output  
15 from said counter to said other pulse signal generator,  
16 with respect to a phase of said count that is output from  
17 said counter to said one pulse signal generator.

1 9. The conveyance robot as set forth in claim 6,  
2 wherein said control unit further comprises:

3 restriction means that, when there is overlap  
4 of said two pulse signals in which said pair of switches  
5 are simultaneously turned on by said one pulse signal and  
6 said other pulse signal that is inverted by said inversion  
7 means, selects one of said two pulse signals and adjusts

8 a waveform of the selected pulse signal to restrict  
9 operation of the switch that is turned on by said selected  
10 pulse signal.

1 10. The conveyance robot as set forth in claim 9,  
2 wherein said restriction means comprises:

3 priority-order determination means for  
4 determining the priority order of said two system motors,  
5 based on the content of a predetermined operation request  
6 made on said two system motors and characteristics of said  
7 moving mechanism to be driven by said two system motors;

8 restriction-ratio setting means for setting,  
9 based on the content of said predetermined operation  
10 request and the characteristics of said moving mechanism,  
11 a restriction ratio of said overlap so that operations  
12 of said two system motors, which are performed according  
13 to said predetermined operation request, end  
14 simultaneously; and

15 adjustment means for selecting as said selected  
16 pulse signal a pulse signal that is output to the motor  
17 with lower priority determined by said priority-order  
18 determination means, and adjusting a waveform of said  
19 selected pulse signal according to said restriction ratio  
20 set by said restriction-ratio setting means.

1 11. A library apparatus comprising:

2 a shelf for storing a cartridge that houses a

3 storage medium;  
4 a deck for accessing said storage medium; and  
5 a conveyance robot for conveying said cartridge  
6 between said shelf and said deck, comprising:  
7 a hand mechanism for inserting and  
8 removing said cartridge while grasping said cartridge,  
9 a moving mechanism, which includes  
10 two system motors, for two-dimensionally moving said  
11 cartridge grasped by said hand mechanism, and  
12 a control unit for simultaneously  
13 controlling operations of said two system motors by  
14 pulse-width modulation;  
15 wherein said control unit of said conveyance  
16 robot comprises:  
17 a pair of switches for supplying driving power  
18 to said two system motors, respectively,  
19 a pair of pulse signal generators for generating  
20 a pair of pulse signals respectively having predetermined  
21 duty ratios at predetermined cycles, and outputting said  
22 pulse signals to said pair of switches to turn on or off  
23 said pair of switches, and  
24 inversion means for inverting, with respect to  
25 a phase of one of said two pulse signals that is generated  
26 and output by one of said two pulse signal generators,  
27 a phase of the other of said two pulse signals, which is  
28 generated and output by the other of said two pulse signal  
29 generators, by 180 degrees.

1     12.         The library apparatus as set forth in claim 11,  
2     wherein said control unit causes said one pulse signal  
3     to rise at a leading edge of said predetermined cycle,  
4     and by inverting the phase of said other pulse signal by  
5     180 degrees by said inversion means of said control unit,  
6     said other pulse signal is caused to fall at said leading  
7     edge.

1     13.         The library apparatus as set forth in claim 11,  
2     wherein:

3                 said control unit further comprises a counter  
4     for counting a clock signal, outputting the count to said  
5     pair of pulse signal generators, and resetting said count  
6     at said predetermined cycles;

7                 said pair of pulse signal generators compare  
8     said count from said counter with duty set values that  
9     are set at said predetermined cycles to determine said  
10    predetermined duty ratios, and generate and output said  
11    two pulse signals according to the result of comparison,  
12    respectively; and

13                said inversion means is constructed as a phase  
14    shifter that inverts a phase of said count that is output  
15    from said counter to said other pulse signal generator,  
16    with respect to a phase of said count that is output from  
17    said counter to said one pulse signal generator.

1     14.         The library apparatus as set forth in claim 11,



2 wherein said control unit further comprises:  
3 restriction means that, when there is overlap  
4 of said two pulse signals in which said pair of switches  
5 are simultaneously turned on by said one pulse signal and  
6 said other pulse signal that is inverted by said inversion  
7 means, selects one of said two pulse signals and adjusts  
8 a waveform of the selected pulse signal to restrict  
9 operation of the switch that is turned on by said selected  
10 pulse signal.

1 15. The library apparatus as set forth in claim 14,  
2 wherein said restriction means comprises:

3 priority-order determination means for  
4 determining the priority order of said two system motors,  
5 based on the content of a predetermined operation request  
6 made on said two system motors and characteristics of said  
7 moving mechanism to be driven by said two system motors;

8 restriction-ratio setting means for setting,  
9 based on the content of said predetermined operation  
10 request and the characteristics of said moving mechanism,  
11 a restriction ratio of said overlap so that operations  
12 of said two system motors, which are performed according  
13 to said predetermined operation request, end  
14 simultaneously; and

15 adjustment means for selecting as said selected  
16 pulse signal a pulse signal that is output to the motor  
17 with lower priority determined by said priority-order

18 determination means, and adjusting a waveform of said  
19 selected pulse signal according to said restriction ratio  
20 set by said restriction-ratio setting means.

1 16. A computer-readable storage medium with a motor  
2 control program for causing a computer to realize a  
3 motor control function of simultaneously controlling  
4 operations of at least two system motors by pulse-width  
5 modulation, said motor control program causing said  
6 computer to function as:

7 a pair of pulse signal generators for generating  
8 a pair of pulse signals, which turn on or off a pair of  
9 switches for supplying driving power to a pair of system  
10 motors among said at least two system motors, respectively,  
11 having predetermined duty ratios at predetermined cycles,  
12 and outputting said pulse signals to said pair of switches;  
13 and

14 inversion means for inverting, with respect to  
15 a phase of one of said two pulse signals that is generated  
16 and output by one of said two pulse signal generators,  
17 a phase of the other of said two pulse signals, which is  
18 generated and output by the other of said two pulse signal  
19 generators, by 180 degrees.

1 17. The computer-readable storage medium as set  
2 forth in claim 16, wherein:

3 said motor control program causes said computer

4 to function as a counter for counting a clock signal,  
5 outputting the count to said pair of pulse signal generators,  
6 and resetting said count at said predetermined cycles;  
7           said motor control program causes said pair of  
8 pulse signal generators to compare said count from said  
9 counter with duty set values that are set at said  
10 predetermined cycles to determine said predetermined duty  
11 ratios, and generate and output said two pulse signals  
12 according to the result of comparison, respectively; and  
13           said motor control program causes said inversion  
14 means to function as a phase shifter that inverts a phase  
15 of said count that is output from said counter to said  
16 other pulse signal generator, with respect to a phase of  
17 said count that is output from said counter to said one  
18 pulse signal generator.

1 18.           The computer-readable storage medium as set  
2 forth in claim 16, wherein said motor control program causes  
3 said computer to function as restriction means that, when  
4 there is overlap of said two pulse signals in which said  
5 pair of switches are simultaneously turned on by said one  
6 pulse signal and said other pulse signal that is inverted  
7 by said inversion means, selects one of said two pulse  
8 signals and adjusts a waveform of the selected pulse signal  
9 to restrict operation of the switch that is turned on by  
10 said selected pulse signal.

1 19. The computer-readable storage medium as set  
2 forth in claim 18, wherein, when said motor control program  
3 causes said computer to function as said restriction means,  
4 said computer is caused to function as:  
5 priority-order determination means for  
6 determining the priority order of said two system motors,  
7 based on the content of a predetermined operation request  
8 made on said two system motors and characteristics of a  
9 device to be driven by said two system motors;  
10 restriction-ratio setting means for setting,  
11 based on the content of said predetermined operation  
12 request and the characteristics of said device, a  
13 restriction ratio of said overlap so that operations of  
14 said two system motors, which are performed according to  
15 said predetermined operation request, end simultaneously;  
16 and  
17 adjustment means for selecting as said selected  
18 pulse signal a pulse signal that is output to the motor  
19 with lower priority determined by said priority-order  
20 determination means, and adjusting a waveform of said  
21 selected pulse signal according to said restriction ratio  
22 set by said restriction-ratio setting means.